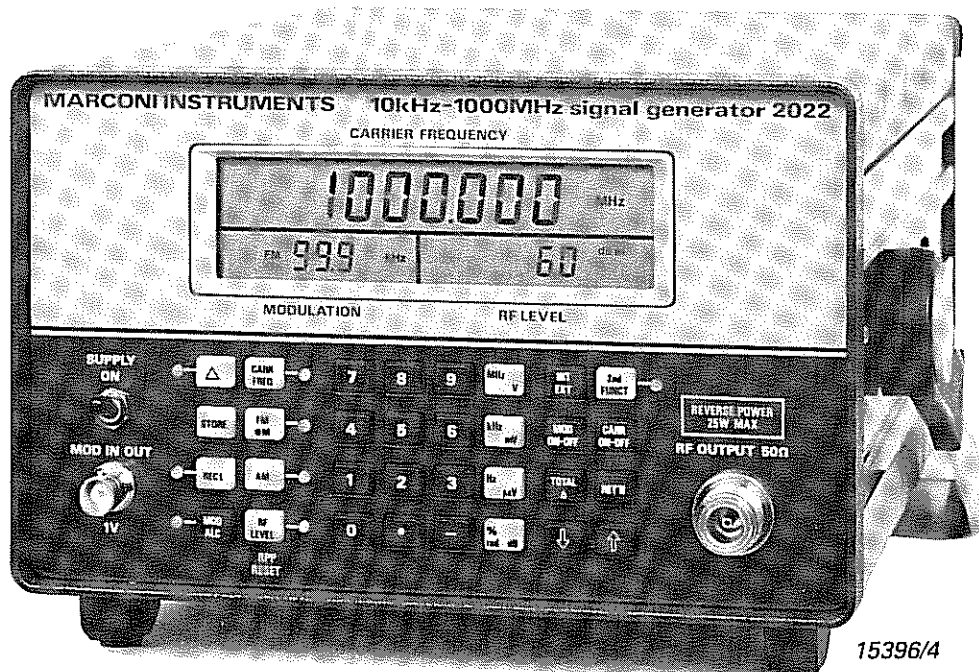


10 kHz to 1000 MHz AM/FM Signal Generator 2022



- ☐ **Wide frequency cover:**
10 kHz to 1000 MHz
- ☐ **Small, light and rugged for portability**
- ☐ **Non-volatile memory with 100 settings**
- ☐ **Powerful second functions for rapid fault finding and calibration**
- ☐ **Comprehensive amplitude, frequency and phase modulation**
- ☐ **Simple push-button operation**
- ☐ **Reverse power protection up to 25 W**
- ☐ **Optional GPIB programmability**
- ☐ **Choice of output calibration units**

2022 is a compact and lightweight Signal Generator, offering frequency, phase and amplitude modulation over the frequency range 10 kHz to 1000 MHz. It is designed for applications in maintenance and servicing, and will also find uses in production and education. Microprocessor control provides simple and rapid operation by direct keyboard entry of settings and the non-volatile memory, which can store up to one hundred settings, further reduces measurement time. Full GPIB programmability adds greater flexibility and faster throughput in systems applications.

Operation

A simple keyboard layout ensures easy operation. All parameters are set using the numeric keys, while up and

down keys allow the values to be varied in steps of any size. A TOTAL SHIFT key displays the deviation from the original setting and a RETURN key returns the selected parameter to the original value. All front-panel functions are available from GPIB when the optional GPIB interface board is fitted.

Frequency, phase and amplitude modulation are selected by operation of the appropriate key, and for rapid measurements of receiver signal-to-noise ratio the modulation can be switched on and off using the MOD ON-OFF key.

Provision is made for operation with an external reference frequency of 1 MHz or 10 MHz as required.

Display

Measurement settings are indicated on a large liquid crystal display, offering clarity and low power consumption. The display features 7-digit resolution for carrier frequency, 3 digits for modulation and 4 for r.f. level, with units annunciators for unambiguous reading. Status and diagnostic information are also shown. Carrier frequency, modulation and r.f. level are all shown together.

Output

RF output levels up to +6 dBm (892 mV e.m.f.) can be set in c.w., f.m. and ϕ .m. modes (reducing linearly with a.m. depth to 0 dBm or 447 mV e.m.f. in a.m. mode) by direct keyboard entry or via the GPIB, with resolution of at least 0.1 dB over the entire range and a total accuracy of ± 1 dB for output levels above -10 dBm and ± 2 dB below -10 dBm. Levels are indicated on a four-digit liquid crystal display with units annunciators and levels can be incremented in steps of any size.

A choice of seven calibration units is available to the operator and provision is made for the simple conversion of units (e.g. dBm to μ V). Calibration data for the output level is held in the memory and may be altered from the front panel or over the interface bus.

The output level can be offset by up to ± 2 dB from the calibrated value to compensate for cable or switching losses external to the generator. The operator may also use this facility as a means of deliberately offsetting the output level to ensure that all generators in an area give identical measurements. While using the offsetting facility the main calibration of the generator is not lost and may be returned to at any time.

Modulation

Comprehensive a.m., f.m. and ϕ .m. facilities are provided for testing all types of receivers. A MOD ON/OFF key is fitted to allow signal-to-noise ratio checks to be made.

The wide range frequency modulation facility provides f.m. deviation up to 99.9 kHz and excellent f.m. accuracy is assured by the storage of calibration values in the memory. Phase modulation is available with a deviation range of up to 9.99 radians and amplitude modulation is provided with steps of 0.5% up to 99.5% depth.

External modulation is possible with a wide band input of 50 Hz to 100 kHz for f.m., 50 Hz to 10 kHz for ϕ .m. and 20 Hz to 50 kHz (d.c. coupled) for a.m. The characteristics of the f.m. input allow the digital signals commonly used in mobile radio to be handled. A modulation levelling function is included which can be disabled when not required. HI and LO indications show when the input level is outside the range of the a.l.c. system.

Incrementing

All parameters can be incremented or decremented in steps of any size, which may be simply entered via the keyboard or GPIB. If no step size is entered for a parameter the steps are pre-set to 1 kHz for carrier frequency, 1 kHz for f.m. deviation, 1 radian for ϕ .m. deviation, 1% for a.m. depth and 1 dB for output level.

A single tap on either the UP or DOWN key moves the parameter by one step. If the key is held down the parameter steps once, waits one second and then moves at three steps per second. For search purposes it is possible to reverse this stepping direction without the one second delay.

Operation of the TOTAL SHIFT key displays the variations in all parameters from their original settings. Use of the RETURN key sets the selected parameter back to its start value.

Non-volatile memory

The inclusion of a true non-volatile semiconductor memory for storage of up to twenty complete generator settings and further eighty carrier frequencies ensures that settings are retained even when the generator is switched off, without relying on a battery. Any of the sets of data can be instantly recalled when required for later use and the UP/DOWN keys may be used to step through a sequence of tests. A further feature enables a single group of preset measurement values to be recalled automatically at switch-on.

In addition to storage and recall of measurement settings, non-volatile memory contains other useful data. Calibration data – on r.f. level, f.m. accuracy and r.f. calibration units are retained in these stores and may be altered using protected Second Functions. Output level offset values are also retained in the instruments' memories and may be selected or deselected by Second Function operation.

Status information stored includes: internal/external standard; GPIB address; type and serial number. Elapsed time indicators are also accessed via the internal memories. One stores the number of operational hours since the instrument was manufactured and cannot be altered. The other records the number of elapsed hours since the clock was last reset; re-settings being accomplished using a secure Second Function.

In GPIB operation the non-volatile memory may be used to store a user-defined string. Up to 32 ASCII characters may be written to, or read from, the 2022, for example to record the instrument's inventory information, date of last calibration, normal instrument location etc.

Programming

2022 can be simply fitted with the optional GPIB interface so that all functions can be controlled over the bus. The instrument functions as talker as well as listener. In the listen mode the generator's functions are set by simple instructions, and in the talk mode strings of information containing details of the instrument's settings can be sent back over the bus, allowing the controller to learn settings for later use.

Ease of programming is ensured by careful selection of mnemonics. For example to send a carrier frequency of 123.456 MHz, an f.m. deviation of 3.5 kHz and an output level of 1.74 μ V, and to place these settings in store 10 of the memory, it is only necessary to send over the bus the instruction CF123.456MZ,FM3.5KZ,LV1.74UV,ST10. The use of commas as delimiters in the instruction string is not essential but often aids interpretation of program lines.

Service requests (SRQ) are sent for a variety of reasons including reverse power protection tripped and illegal characters received. SRQs may be inhibited if desired by settings flags in the generator using a Second Function.

Second Functions

The front panel Second Function key gives access to a number of different features available with 2022. Some of these are related to maintenance, calibration and programmable operation via GPIB. To prevent accidental

interference with the contents of internal memories, those Second Functions that enable the internal data to be altered are protected by a secure key sequence.

Two levels of protection are offered, appropriate to the Second Function being accessed. The most secure is reserved for Second Functions that alter the instruments' calibration data, change its identity string, protect its store settings or blank the displays when memories are recalled. Less severe is the first level of protection, which enables the user to access those Second Functions that do not affect the fundamental calibration, but which may be relevant to normal operation. Examples include the selection of: r.f. level calibration units, r.f. level offsets, external standard frequency and switch-on status.

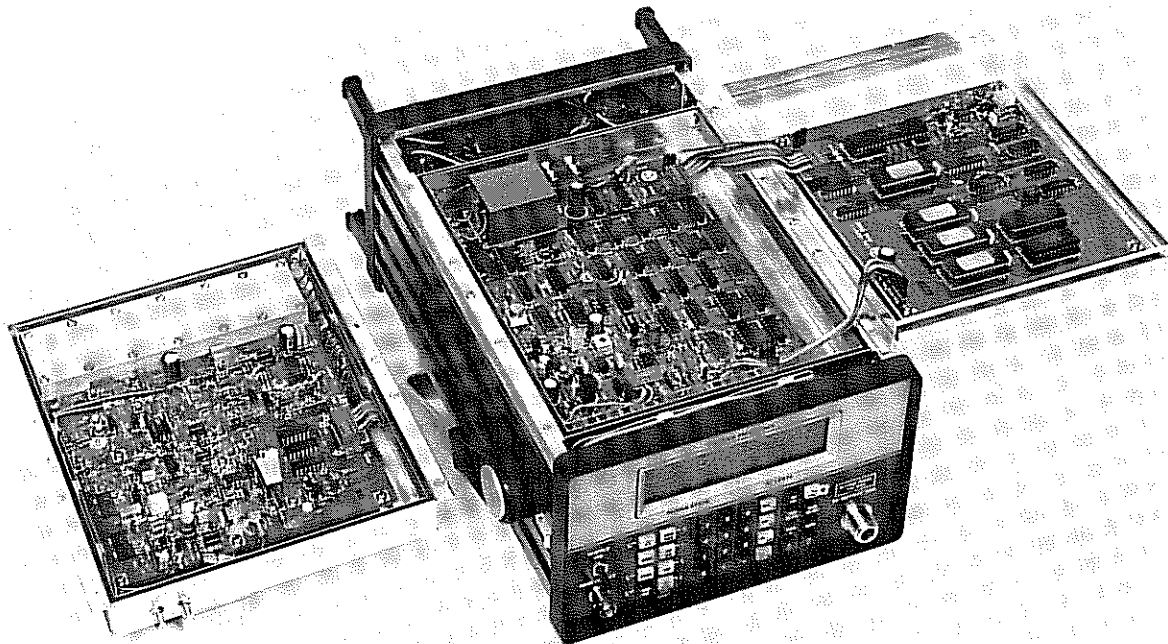
In addition, unprotected Second Functions provide a range of additional operating features, such as the ability to display status information, elapsed time and the type and serial number.

Maintenance and calibration

The Second Function mode provides powerful fault diagnostic facilities from the front panel or via the GPIB by allowing the operator to send data directly to individual latches in the instrument. The resulting changes in output conditions can be monitored and the area in which the fault lies can be localized quickly.

RF level, f.m. accuracy and frequency accuracy can be adjusted without removing the instrument's covers. Level and f.m. accuracy can be adjusted over the GPIB, leading to fully automated calibration routines.

Careful mechanical design of the instrument ensures rapid access to all circuits for p.c.b. or component replacement. The main r.f. assemblies are easily removed for inspection and repair, as shown in the photograph. Printed boards interconnect by means of plugs and sockets so simplifying first line maintenance.



Easy access to 2022's interior ensures low cost of maintenance and repair.

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GENERAL DESCRIPTION		2022 is a synthesized signal generator covering the frequency range 10 kHz to 1000 MHz. The output may be amplitude, phase or frequency modulated using either the built-in a.f. source or an external signal. All control settings are entered from a front panel keyboard. A single liquid crystal display gives simultaneous read-out of frequency, modulation and output level. Remote control via the General Purpose Interface Bus is available as an option.	Selection		By keyboard entry. Units may be μV , mV, V a.m.f. or p.d.; dB relative to 1 μV , 1mV a.m.f. or p.d; dBm.
CARRIER FREQUENCY			Indication		4 digit l.c.d. with units annunciators. See KEYBOARD AND DISPLAYS.
Range		10 kHz to 1000 MHz.	Displayed resolution		0.1 dB or better over the entire voltage range.
Selection		By keyboard entry.	Output level accuracy		± 1 dB for output levels above -10 dBm ± 2 dB for output levels below -10 dBm.
Indication		7 digit l.c.d. — see under KEYBOARD AND DISPLAYS.	Output impedance		50 Ω , type N female socket to MIL 90123D. VSWR is better than 1.5:1 for output levels below -10 dBm.
Displayed Resolution		10 Hz up to 100 MHz, 100 Hz above 100 MHz.	Reverse power protection		An electronic trip protects the generator output against reverse power of up to 25 W from d.c. to 1 GHz. For safety the output socket is automatically disconnected from the attenuator when the power is switched off. The trip may be reset from the front panel or via the GPIB.
Accuracy		Equal to the frequency standard accuracy. See FREQUENCY STANDARD.			
RF OUTPUT					
Level		-127 to $+6$ dBm (0.2 μV to 892 mV a.m.f.) in c.w. and f.m. modes. When a.m. is selected the maximum output power reduces linearly with a.m. depth to 0 dBm (447 mV a.m.f.) at maximum a.m. depth.			

SPURIOUS SIGNALS**Harmonically related signals**

Better than -25 dBc for output levels less than 0 dBm for any carrier frequency.

Sub-harmonics (at output levels below 0 dBm.)

None for carrier frequencies up to 500 MHz, better than -20 dBc for carrier frequencies above 500 MHz.

Non-harmonically related signals (at output levels below 0 dBm.)

At offsets from the carrier of 3 kHz or greater: For carrier frequencies above 62.5 MHz better than -70 dBc. For carrier frequencies below 62.5 MHz; better than -55 dBc in the band up to 150 MHz, and better than -40 dBc in the band above 150 MHz.

Residual f.m.

Less than 20 Hz equivalent peak deviation in a 300 Hz to 3 kHz bandwidth at 499 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 62.5 MHz. Better than 10 Hz below 62.5 MHz.

RF leakage

Less than 0.5 μ V p.d. generated in a 50 Ω load by a two-turn, 25 mm loop, 25 mm or more from the case of the generator, with the output level set to less than -10 dBm and the output terminated in a 50 Ω sealed load.

FREQUENCY MODULATION**Range**

Peak deviation from 0 to 99.9 kHz for all carrier frequencies.

Displayed resolution

10 Hz for deviations up to 9.99 kHz. 100 Hz for deviations from 10 kHz to 99.9 kHz.

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected.

Display

3 digit f.c.d. See KEYBOARD AND DISPLAYS.

Deviation accuracy

$\pm 5\%$ of deviation at 1 kHz modulating frequency excluding residual f.m.

Frequency response

± 1 dB from 10 Hz to 25 kHz relative to 1 kHz, using external modulation input and a.i.c. off.

± 1 dB from 50 Hz to 25 kHz relative to 1 kHz using external modulation input and a.i.c. on.

With a.i.c. off, can be used for 10 Hz square wave switching.

Distortion

Less than 5% total harmonic distortion at 1 kHz modulating frequency and maximum deviation for any carrier frequency above 250 kHz.

External modulation

With modulation a.i.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.i.c. With modulation a.i.c. off, the deviation is calibrated for an input level of 1 V p.d.

Input impedance: 100 k Ω nominal.

PHASE MODULATION**Range**

Peak deviation from 0 to 9.99 radians.

Displayed resolution

0.01 radians.

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected.

Deviation accuracy

$\pm 5\%$ of deviation at 1 kHz modulating frequency excluding residual p.m.

Frequency response

± 1 dB from 10 Hz to 10 kHz relative to 1 kHz, using external modulation input and a.i.c. off.

± 1 dB from 50 Hz to 10 kHz relative to 1 kHz using external modulation input and a.i.c. on.

Distortion

Less than 5% total harmonic distortion at 1 kHz modulating frequency and maximum deviation for any carrier frequency above 250 kHz.

External modulation

With modulation a.i.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.i.c. With modulation a.i.c. off, the deviation is calibrated for an input level of 1 V p.d.

Input impedance: 100 k Ω nominal.

AMPLITUDE MODULATION**Range**

0 to 99.5%.

Resolution

0.5%.

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected.

Display

3 digits. See KEYBOARD AND DISPLAYS.

Accuracy

Better than $\pm (4\%$ of depth setting $+1\%$) for 1 kHz modulating frequency and depths of: 0 to 95% for carrier frequencies up to 62.5 MHz; 0 to 80% for carrier frequencies up to 400 MHz.

Frequency response

± 1 dB from 50 Hz to 15 kHz relative to 1 kHz at 80% depth using external mod. input and a.i.c. on. DC coupled with a.i.c. off.

Envelope distortion

Less than 5% total harmonic distortion at 1 kHz modulating frequency for depths of: 0 to 95% for carrier frequencies up to 62.5 MHz; 0 to 80% for carrier frequencies up to 400 MHz.

External modulation input

With modulation a.i.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.i.c. With modulation a.i.c. off, the modulation depth is calibrated for an input level of 1 V p.d.

Input impedance: 100 k Ω nominal, d.c. coupled.

MODULATION OSCILLATOR**Frequency**

1 kHz.

Frequency accuracy

As reference frequency standard.

Distortion

Less than 1% total harmonic distortion.

FREQUENCY STANDARD**Frequency standard input**

Internal or external frequency standard may be selected from the front panel. Annunciators show which is selected.

A rear-panel BNC socket provides an external standard input when external standard is selected.

INTERNAL FREQUENCY STANDARD**Frequency**

High stability oven-controlled crystal oscillator. 10 MHz.

Temperature stability

Better than ± 0.2 p.p.m. over the temperature range 0 to 40°C.

Warm-up time

Within 0.5 p.p.m. of final frequency 5 min. from switch-on at 20°C ambient.

Ageing rate

Better than 0.1 p.p.m. per month after 1 month's continuous use at constant ambient temperature.

EXTERNAL FREQUENCY STANDARD**External standard input**

Accepts a 10 MHz signal of at least 1 V r.m.s. into a 100 Ω nominal impedance. A 5 MHz or 1 MHz signal can be accepted by changing an internal link. Connection is via a rear panel BNC socket.

AUXILIARY INPUTS AND OUTPUTS**Modulation input/output**

A front panel BNC socket provides an output from the modulation oscillator when internal modulation is selected and becomes the external modulation input when external modulation is selected.

The input signal may be levelled by selecting